# High-Performance WLAN Architectures Using MIMO Technology in Line-of-Sight

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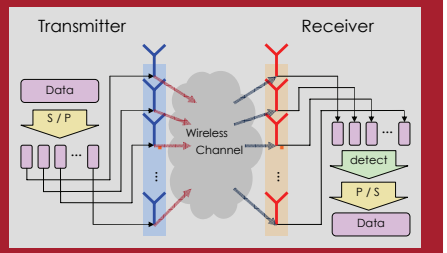
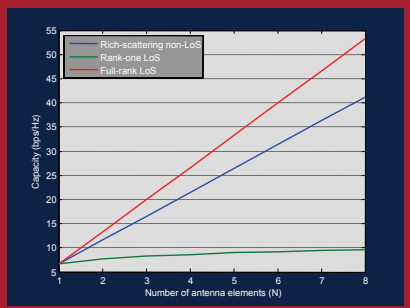
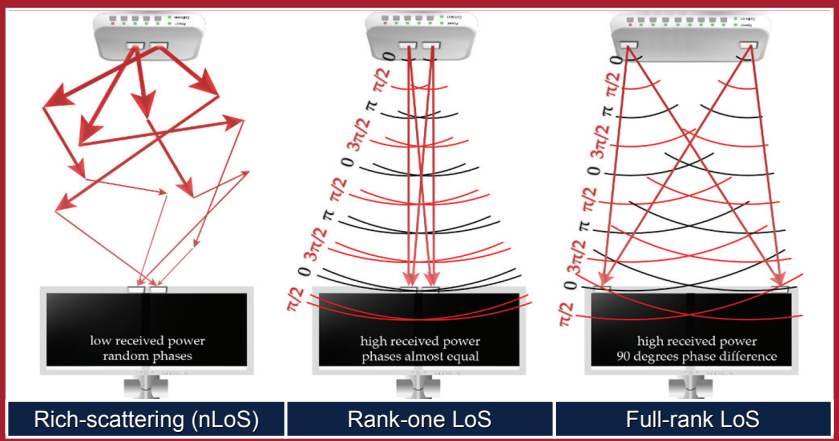
## MIMO Systems

Multiple-Input Multiple-Output communications systems can achieve significant capacity enhancements over conventional SISO systems by exploiting multiple spatial sub-channels (propagation paths)



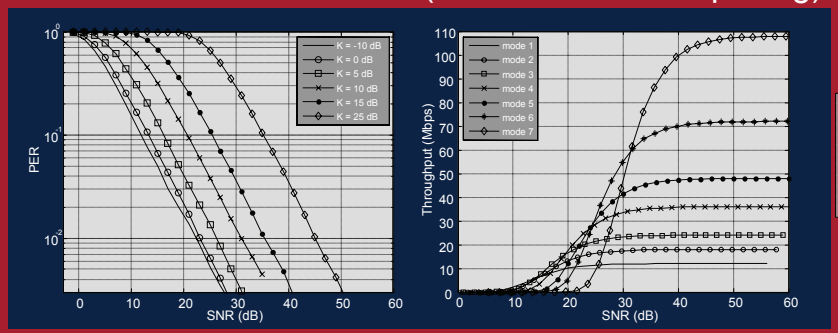




- In a rich-scattering environment the capacity increases linearly with the number of elements (*N*)
- In the case of a strong LoS signal the capacity increase with *N* is usually insignificant
- Only systems with specifically designed antenna arrays can achieve high capacities in LoS




## Link-Level Simulation Results

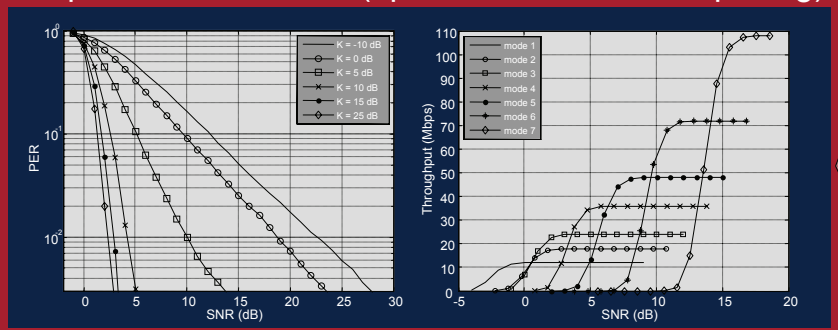
### Conventional Architecture ($\lambda/2$ inter-element spacing)




**32 dB** improvement in SNR (K=15dB, PER=$10^{-2}$)

**7x** improvement in throughput (K=15dB, SNR=18dB)

### Proposed Architecture (optimal inter-element spacing)




- When a strong LoS signal exists (i.e. for large values of *K*-factor) there is a very significant performance enhancement associated with arrays designed following the proposed architecture over standard systems
- On the extreme of a very low *K*-factor the performance approaches the i.i.d. Rayleigh model that corresponds to a rich-scattering environment

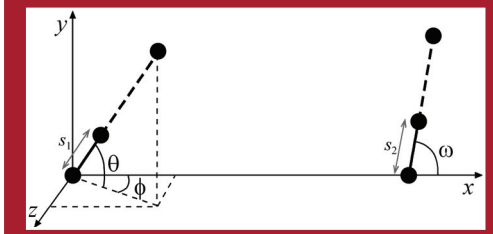
# Maximum Capacity Structures

The capacity of a MIMO system is maximised for: $\mathbf{H}\mathbf{H}^H = N \cdot \mathbf{I}_N$

*Where $\mathbf{H}$ is the channel response matrix, $\mathbf{I}$ is the identity matrix and $^H$ denotes the complex conjugate transpose operation*

For the case of Uniform Linear Arrays at both the transmitter and the receiver, a simplified maximum capacity criterion has been derived

$$s_1 s_2 \approx \lambda\left(\frac{1}{N}+r\right)\frac{D}{\sin\omega\sin\theta},\ r \in \mathbf{Z}^+$$

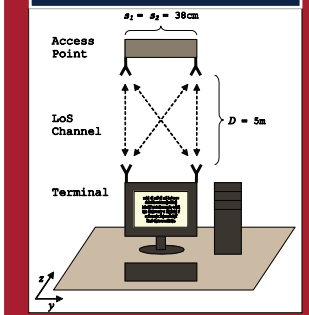



This criterion can be used to design high capacity MIMO structures for environments with strong LoS signal

Some typical applications are shown below:

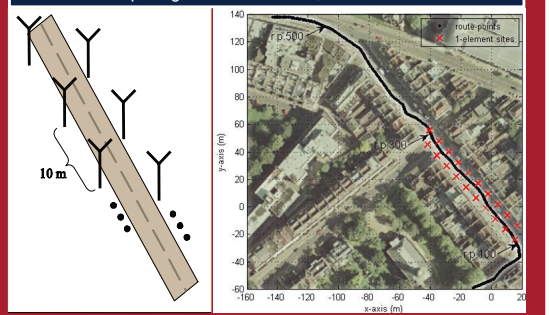
## Indoor deployment

Frequency = 5.2 GHz
T-R distance = 5m
Inter-element spacing = 38cm

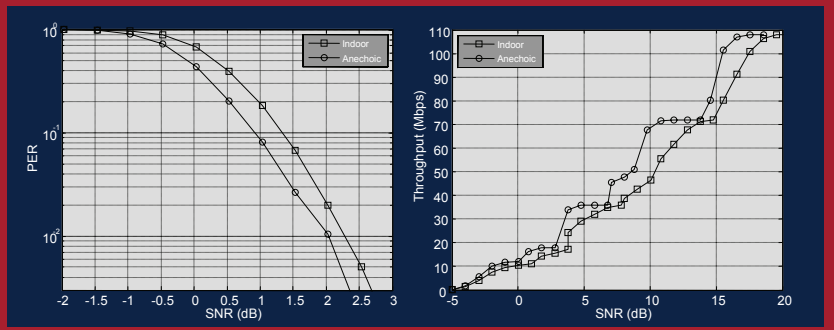



## Outdoor (distributed) deployment

Frequency = 5.2 GHz
Height of AP elements = 10 m
Height of MT = 1.5 m
Inter-element spacing = 10 m on the AP, 4 cm on the MT

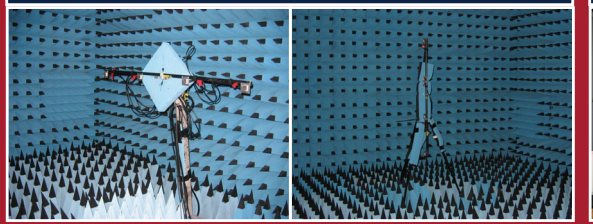



# Measurement Results




- Very close agreement was observed between the measured and the simulated results (~0.5 dB difference)
- The performance of the indoor system was not significantly affected by the existence of multipath

Anechoic Chamber



Indoor Office

# Current / Future Work (ASTRALS project)

- Evaluation of the proposed MIMO scheme at 5 GHz in the home environment
- Development of suitable antenna systems for high capacity MIMO in LoS
- Development of a MIMO transmission prototype based on a modified Elektrobit C8 propagation simulator

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